MINING METHODS AND COSTS AT THE ATLAS NO. 2 ZINC-LEAD MINE, WEST PINOS ALTOS MINING DISTRICT, GRANT COUNTY, N. MEX.

BY WALTER R. STORMS

* * * * * * * * * **Information Circular 7524**

A Century of Conservation

1849 1949

UNITED STATES DEPARTMENT OF THE INTERIOR
J. A. Krug, Secretary
BUREAU OF MINES
James Boyd, Director

The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Information Circular 7524."

October 1949

MINING METHODS AND COSTS AT THE ATLAS NO. 2 ZINC-LEAD MINE, WEST PINOS ALTOS MINING DISTRICT, GRANT COUNTY, N. MEX.

by

Walter R. Storms[1]

CONTENTS

	Page
Introduction and summary	2
Acknowledgments	2
History	2
Geology	4
Methods of prospecting and exploration	6
Methods of sampling and estimation of tonnages and values	6
Development methods	
Shafts	6
Drifts and crosscuts	7
Mining (stoping) methods	8
Transportation	9
Ventilation	9
Drainage	10
Organization and wage scale	10
Costs	10

TABLES

1. Production from Houston-Thomas claims 3
2. Production from Atlas No. 2 mine 3
3. Summary of costs 11
4. Costs per ton 11

ILLUSTRATIONS

Fig.		Follows page
1.	Location map	2
2.	Topography and geology	4
3.	Sections on drill holes	4
4.	Mine workings	4
5.	Section through mine	4
6.	Section through stope	4
7.	Headframe, bin, and skip	6

---

[1] Senior mining engineer, Bureau of Mines.

Information Circular 7524

INTRODUCTION AND SUMMARY

This paper, which gives the history and production of the Atlas No. 2 zinc-lead mine and describes mining and sampling methods and costs, is one of a series being prepared by the Mining Division of the Bureau of Mines on mining practices, methods, and costs in various mining districts of the United States. The mine is in the Houston-Thomas group of lode claims in the west Pinos Altos Mining District, Grant County, N. Mex.

The Atlas No. 2 mine and surface plant are situated in the southwestern corner of sec. 36, T. 16 S., R. 14 W., about 8 miles by road north and slightly east of Silver City. A spur line of the Atchison, Topeka & Santa Fe Railroad connects this city with the main line of the Southern Pacific Railroad at Deming, some 50 miles southeast. Paved U. S. Highway 260 also connects these cities. A good county road connects the mine with Silver City.

ACKNOWLEDGMENTS

Acknowledgment is made to Andrew B. Stewart, owner of the Houston-Thomas property, where the Atlas No. 2 mine is situated, and to the lessees of the mine, James Mathis and sons. Special acknowledgment also is due J. H. Hedges, chief of the Tucson Branch of the Mining Division, Bureau of Mines, for his suggestions and help, and to John H. Soulé, mining engineer with the same branch and division of the Bureau of Mines, for many of the data on history and geology and for the use of several of his maps.[2]

HISTORY

The history of the Pinos Altos district dates back to the discovery of gold placers on the east side of the mountains about 1860. The gold lode mines were found shortly thereafter, and the area was productive until the early part of the 20th century.

Other than prospecting, little was done during this time on the western side of the mountains. A few tons of oxidized surface ores were shipped, and a small gold property was operated. The Empire Zinc Co. acquired the Cleveland mine in 1913 and started operations. They constructed a magnetic concentrator and operated until 1919. In 1929 they initiated an extensive exploratory program on their own and adjoining properties. In 1942 Douglas B. White leased the Cleveland group. Mining of new ore was done by sublessees while White constructed a small mill to treat the old tailing dumps. White later produced some ore from the Cleveland mine prior to July 1947, some time after sublessees had ceased operations.

Early operations on the Houston-Thomas group were confined to the easily accessible oxidized surface ores. B. O. Shepherd acquired these claims in 1943 and began mining sulfide zinc-lead ores from the old Stevens adit.

---

[2] Soulé, John H., West Pinos Altos Zinc-Lead Deposits, Grant County, N. Mex.: Bureau of Mines Rept. of Investigations 4237, 1948, 8 pp.

Original from THE OHIO STATE UNIVERSITY

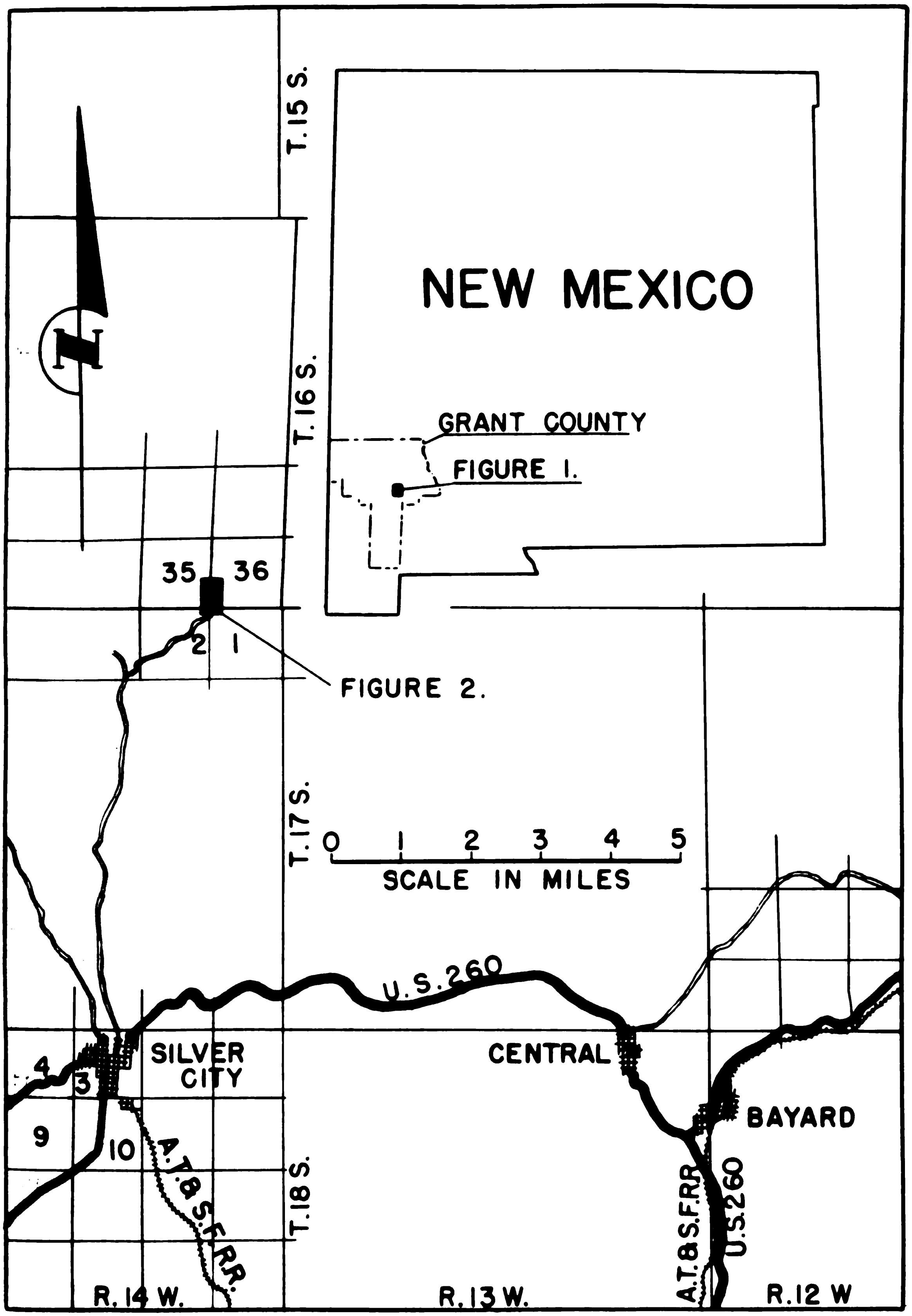

Figure 1. - Location map.

Original from THE OHIO STATE UNIVERSITY

Andrew B. Stewart purchased the property from Shepherd in late 1945 and for a while confined his operations to a small gold-bearing vein near the northern end of the claim group. This operation was not satisfactory because of the high smelter penalties exacted on the high bismuth content of the ore.

Stewart, through lessees, conducted a geophysical survey of his property in 1946. This survey coincided with a Bureau's development project, and some of the data were used by the Bureau. One anomaly core-drilled by the Bureau of Mines disclosed a new zinc-lead ore body. Exploitation and development of this ore body were undertaken immediately upon its discovery.[3]

Production figures for the Houston-Thomas property are shown in the following tables:

TABLE 1. - Production from Houston-Thomas claims[1]

Year	Ore, tons	Ounces per ton		Percent		
		Gold	Silver	Copper	Lead	Zinc
Prior to 1905	200-300	--	--	--	--	--
About 1918	Small amount	--	--	--	--	--
1922	6,398	--	--	--	--	--
1923	628	--	--	--	--	--
1943	302	0.03	5.3	0.5	1.6	6.4
1944	2,018	0.02	4.4	0.4	2.9	8.0
1945	322	0.01	2.9	0.2	2.5	6.9
1946	45	0.03	5.8	0.4	3.4	9.5
Total	10,013					
1946-1947	[2]1,018					

[1] Includes ore from shallow surface workings, the Stevens Adit workings, and the Atlas No. 1 shaft workings.

[2] Bismuth-bearing gold ore containing $19,773.

TABLE 2. - Production from Atlas No. 2 mine

Date	Dry tons	Ounces per ton		Percent		
		Gold	Silver	Copper	Lead	Zinc
May 1947	90.005	--	1.79	--	2.08	7.34
June 1947	808.161	--	2.67	--	1.31	9.95
July 1947[1]	180.938	--	2.57	--	1.24	10.60
Aug. 1947[1]	477.055	--	2.52	--	1.03	10.12
Sept. 1947	1,509.286	--	3.93	--	2.19	10.84
Oct. 1947	1,690.607	--	4.02	--	2.57	10.39
Nov. 1947	1,864.146	--	3.19	--	3.75	9.35
Dec. 1947	1,553.849	--	2.92	--	2.76	9.96
Total	8,174.047	--	3.33	--	2.55	10.07

[1] Mine was shut down during latter part of July and first part of August while shaft was enlarged and skip installed.

---

[3] See footnote 2.

GEOLOGY

The oldest exposed rocks in the West Pinos Altos district are the Magdalena limestones of Pennsylvanian age. These are overlain by the Beartooth quartzite of Cretaceous age, which, in turn, underlies the Colorado sandstones and shales, also of Cretaceous age. The limestones generally dip gently to the east, whereas the other sedimentary rocks generally dip gently to the west. The generalized areal geology is shown in figure 2.

Diorite porphry intrudes these rocks. The intrusives occur as irregular dikes and sills and possibly as stocklike masses of varying size. The small dikes and sills seem confined to the Magdelena limestones, whereas the larger intrusives occur throughout the sedimentary series. Small andesite dikes were noted in the shales.

The diorite underlies all known ore-bearing areas. Data are not available to show whether this is a very thick sill or a stocklike mass. One old diamond-drill hole shows the thickness of the diorite to exceed 600 feet. If this is a sill, the limestones beneath it should be the Hanover, which is the principal ore-bearing formation in the Central Mining District.

Faulting is complicated in detail. Three faults of large magnitude are known, as well as many minor ones. The earliest large fault is shown by the displacement of the sandstone and shale beds. This is a reverse or thrust fault and occurs in the northern part of the area. It probably strikes from northwest to southeast. The dip is southwest. This fault is pre-mineral and pre-intrusive. Subsequent activity has obliterated its traces except for the displacement of the beds. Also, no mine openings were made between the displaced beds, and a surface trace of the fault may be concealed by detrital material. Section A-A in figure 3 shows the emplacement of older limestone beds upon the younger shales and sandstones, which was caused by this fault. The apparent vertical displacement of this fault exceeds 1,000 feet. No data are available as to its horizontal displacement.

A later major fault, which bounds the western part of the district, has butted the limestones against later igneous rocks. This fault is normal and has been traced for a considerable distance. It does not traverse the mapped area, as shown in figure 2. The Cleveland fault seems to be a spur from this large fault and traverses the area as shown in figure 2. The Cleveland fault is normal, post-intrusive, and presumably post-ore. It strikes a little east of north and dips steeply to the west, with the down throw to the west. The vertical displacement is about 300 feet, and the horizontal displacement may be as much as 500 feet.

Many minor faults and shear zones traverse the area. They usually strike northeast-southwest, and dip steeply, generally to the northwest. Some of these faults are mineralized.

Gossans, some quite extensive, occur in the limestone, and it is from these that the production of carbonate ores was derived. These gossans seem to be the residuum of exposed, altered, sulfide ore bodies. Some gossans

Original from THE OHIO STATE UNIVERSITY

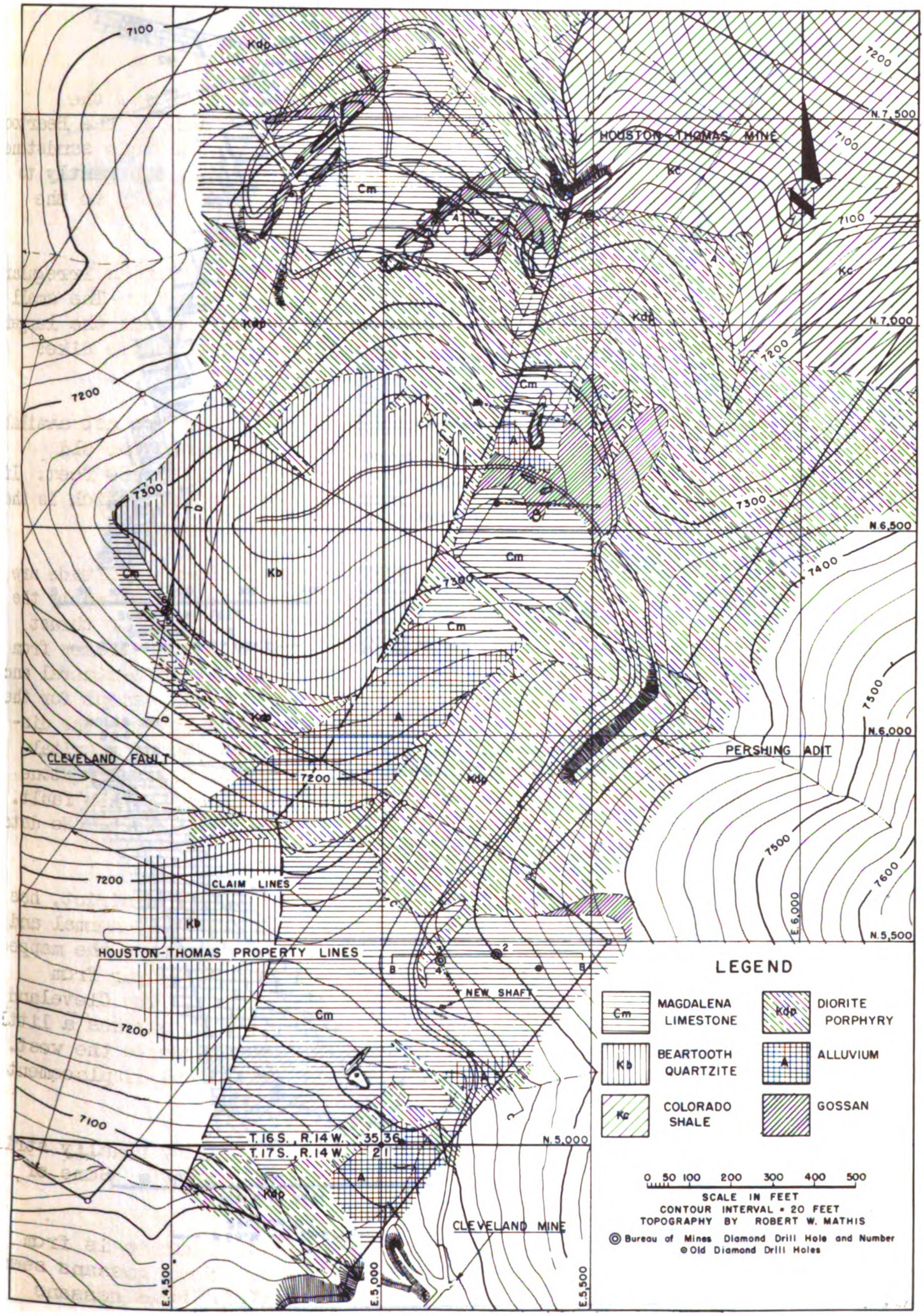

Figure 2. - Topography and geology.

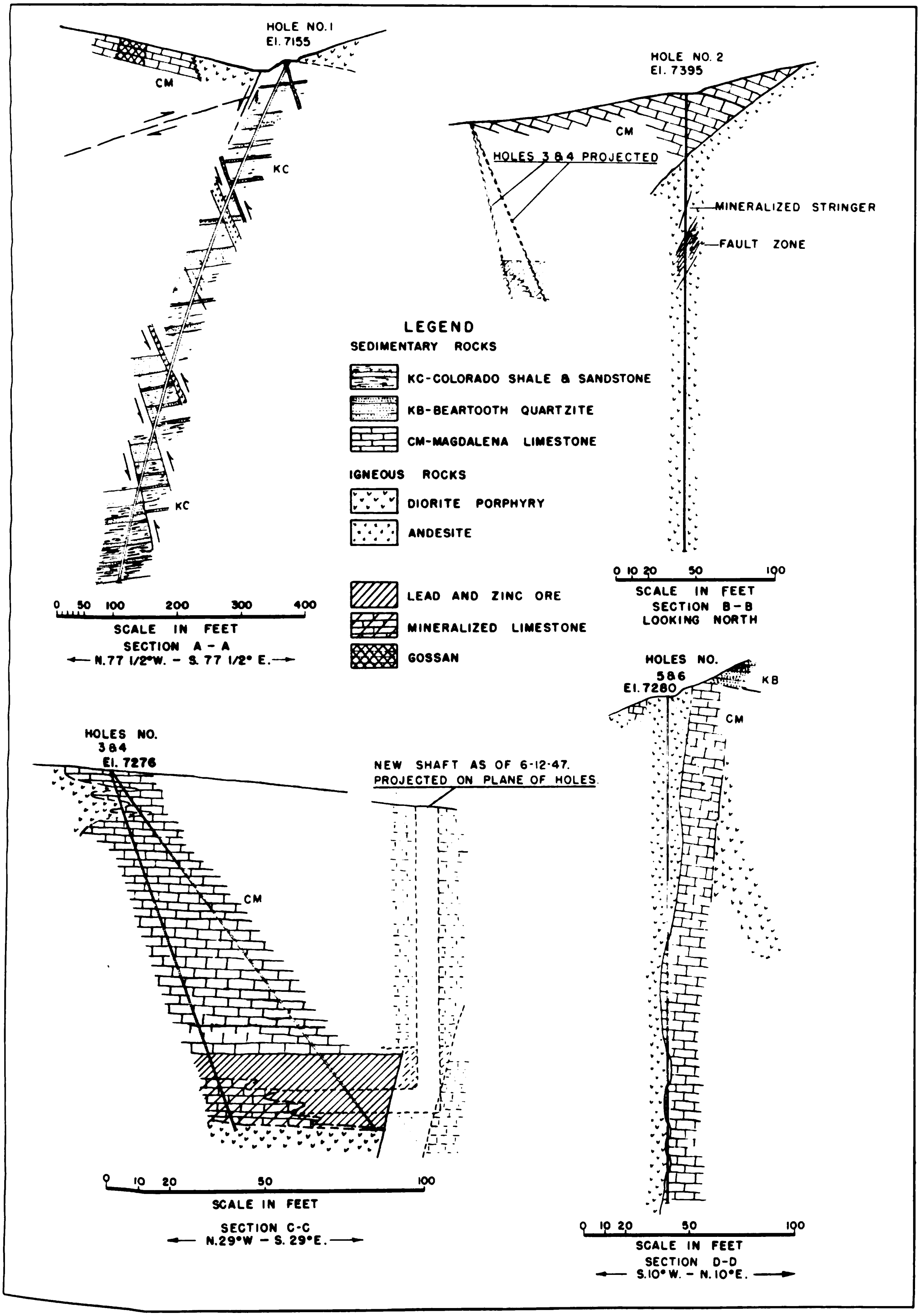

Figure 3. - Sections on drill holes.

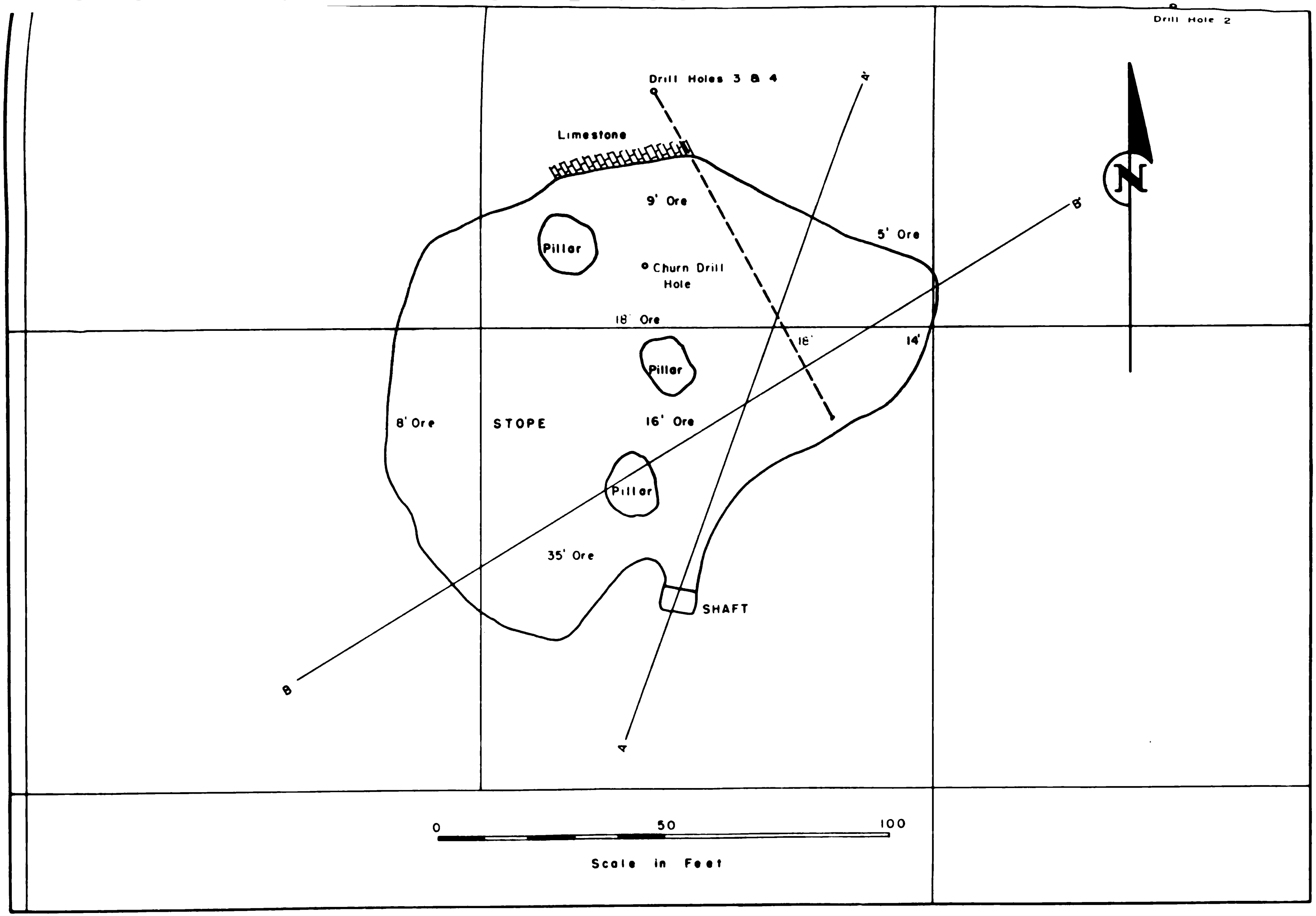

Figure 4. - Mine workings.

Original from THE OHIO STATE UNIVERSITY

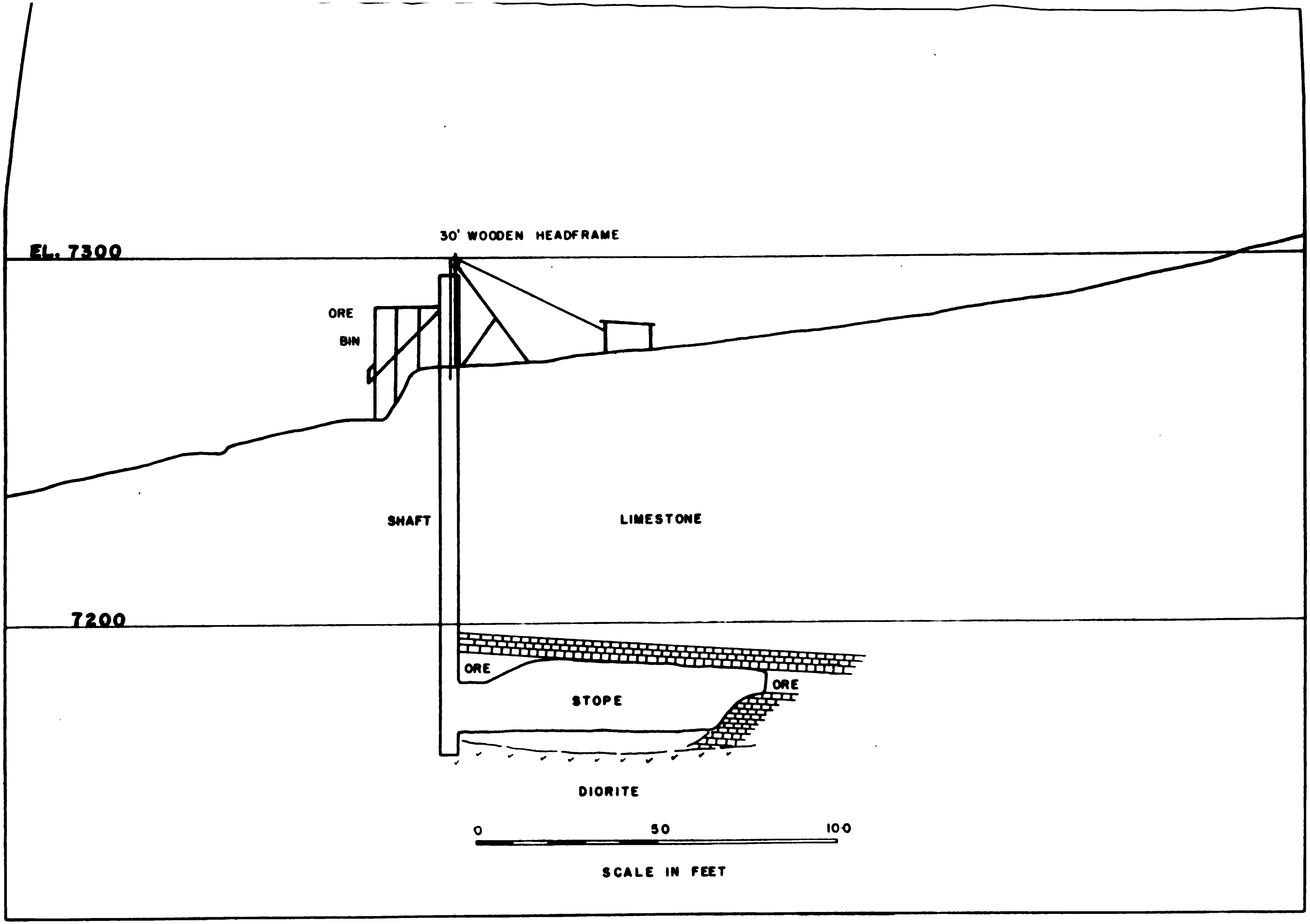

Figure 5. - Section through mine.

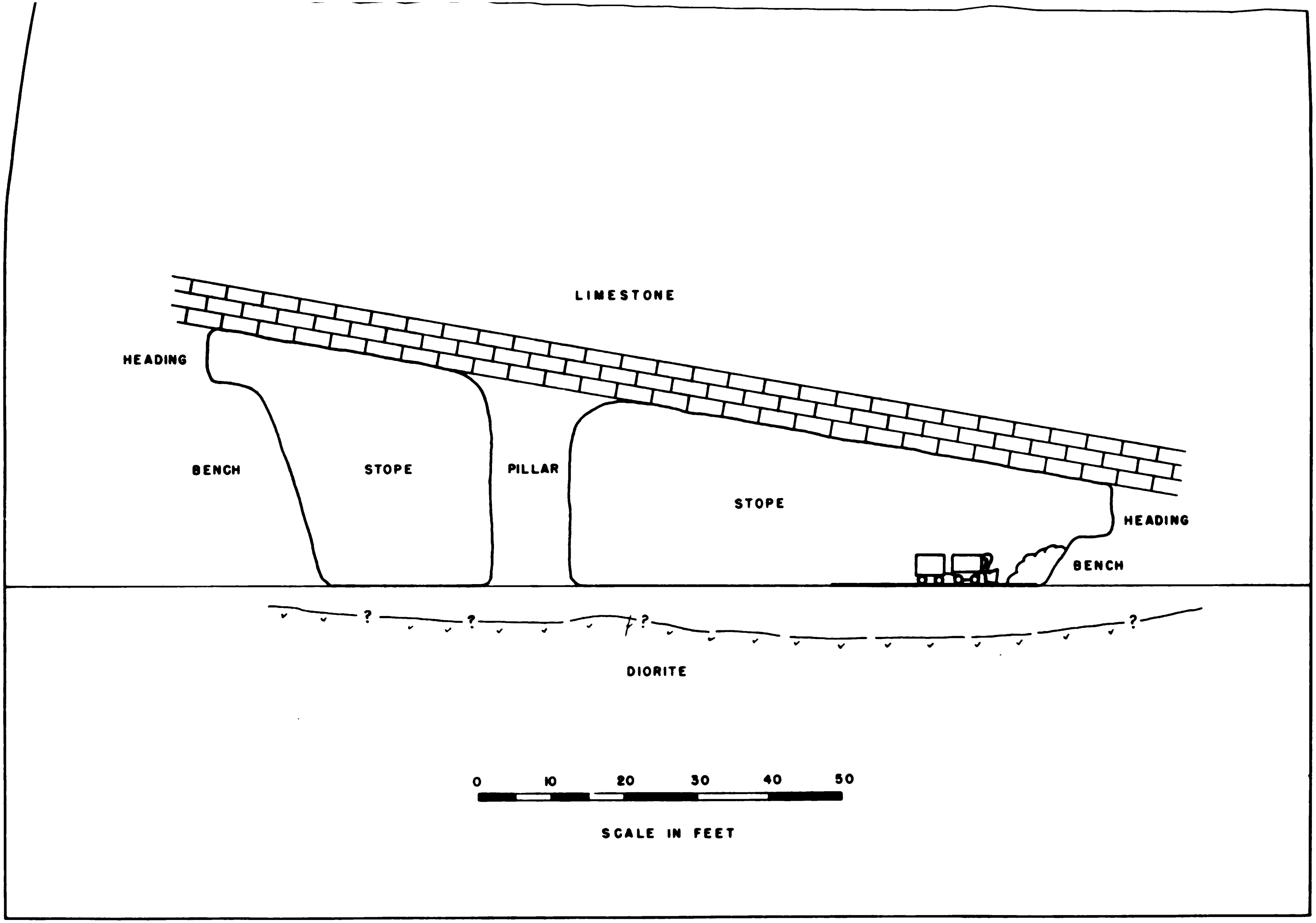

Figure 6. - Section through stope.

represent completely oxidized sulfide ore bodies, others incomplete alteration where unaltered sulfides underlie the gossans, and other sulfide ore bodies were so deeply buried that no gossan was formed.

The sulfide ore bodies are the most important. They occur as irregular, flat-lying, tabular replacement deposits of varying dimensions. One old stope measured almost 200 feet in length, 50 feet in width, and was 15 feet high.

The sulfide ore is a complex zinc-lead ore with both carbonate and silica gangue. Pyrite is plentiful. Marmatite, an iron-rich sphalerite, is the major economic mineral, followed by galena. Copper occurs as chalcopyrite. The silver content of the ores is appreciable and probably occurs with the galena. Gold is found in minute quantities.

The carbonate minerals, smithsonite, cerussite, and malachite occur in the gossans along with hematite, limonite, pyrolusite, and some unaltered minerals of the original sulfide ore body.

In the northern part of the district, two small veins were worked for gold. Bismuth minerals were an important constituent of one of these veins. The bismuth occurred as the sulfide bismuthinite, probably as the native metal, and also as an oxidized mineral. Most of the gold was free.

Alteration of the sedimentary rocks by the intrusives was not severe. Some garnetization was noted, as was silicification. Recrystallization of the limestone as marble was not pronounced. The sandstone and shales were quartzitic in places.4/

At the Atlas No. 2 mine (fig. 4) the ore occurs as a replacement deposit along the bedding of the Magdalena limestone, dipping about 16° easterly (see fig. 6). Fairly unaltered limestone occurs above the ore body, while diorite seems to occur only a short distance beneath it (see figs. 3, 5, and 6). Some barren limestone horses occur in the bedded deposit, and some walls of the open stope have encountered mineralized limestone that is too low in lead and zinc to be classed as ore at the present time. However, the ore body seems to trend slightly south of west and, as indicated by geophysical data, should extend westward to the Cleveland fault (see fig. 2). So far as is known, the ore shoot at the Atlas No. 2 ranges up to 35 feet in thickness. The upper part of the deposit follows the bedding plane of the limestone, although the bottom is more irregular, with diorite seemingly occurring only a few feet beneath the ore body.

Sphalerite, with lesser amounts of galena and chalcopyrite, occurs with pyrite, calcite, and silicified limestone. Small amounts of silver occur with the galena, but the gold content of the ore is very low. In 1947 the ore averaged 10.07 percent zinc, 2.55 percent lead, and 3.33 ounces of silver per ton. Copper ranged up to 0.61 percent, but gold was only about 0.02 ounce per ton.

4/ Up to this point, the section on Geology was taken almost verbatim from R. I. 4237 (see footnote 2).

METHODS OF PROSPECTING AND EXPLORATION

The Bureau of Mines conducted an exploratory project at the Houston-Thomas property from August 1946 to April 1947. During this period, six holes were diamond-drilled, totaling 1,824 feet. Of these, Nos. 3 and 4 discovered the Atlas No. 2 ore body after the lessees had made a geophysical survey on the property for the owner and had noted a large anomaly at that site. Figure 2 shows the location of these drill holes, and figure 3 shows a section along the holes. This exploratory project has been described fully in a previous publication.[5]

After this ore body had been found by the two drill holes, the lessees, James Mathis and sons, immediately sank a shaft to the ore deposit and began to mine it. Very little additional prospecting or exploratory work was done, as stoping started almost as soon as the ore was encountered.

Andrew B. Stewart, the owner, started a diamond-drill hole a few hundred feet to the west of the known ore in order to prove its extension in that direction, but his work was stopped when exploration premiums were discontinued by the Government on January 1, 1948. No other exploratory work had been done at the time this report was written (February 1948).

METHODS OF SAMPLING AND ESTIMATION OF TONNAGES AND VALUES

Only a few chip samples have been taken to guide stoping operations. Visual inspection of stope faces usually is employed to decide which is ore and which is waste. The mine foreman inspects the faces after each round and then tells the miners where to drill.

No estimation has been made of ore reserves and values.

DEVELOPMENT METHODS

Shafts

After Bureau of Mines drill hole 4 had shown that the ore body found by hole 3 was a flat-lying deposit, the lessees immediately moved in equipment and started to sink a small shaft to the ore. This original shaft was 5 by 8 feet in cross section, with a ladderway at one end and space for the hoisting bucket at the other.

The shaft sinking was done with jackhammers using 1-inch, hollow, round steel with detachable bits. Ventilation was provided with a small gasoline engine-powered fan with canvas ventilation tubing. Compressed air was furnished by a 210-c. f. m. portable compressor. At first a tripod headframe was used with a small sinking bucket and a gasoline engine-powered hoist. Only the upper part of the shaft for a short distance down from the collar was timbered with cribbing. The rest of the shaft was sunk with only occasiona

---

[5] See footnote 2.

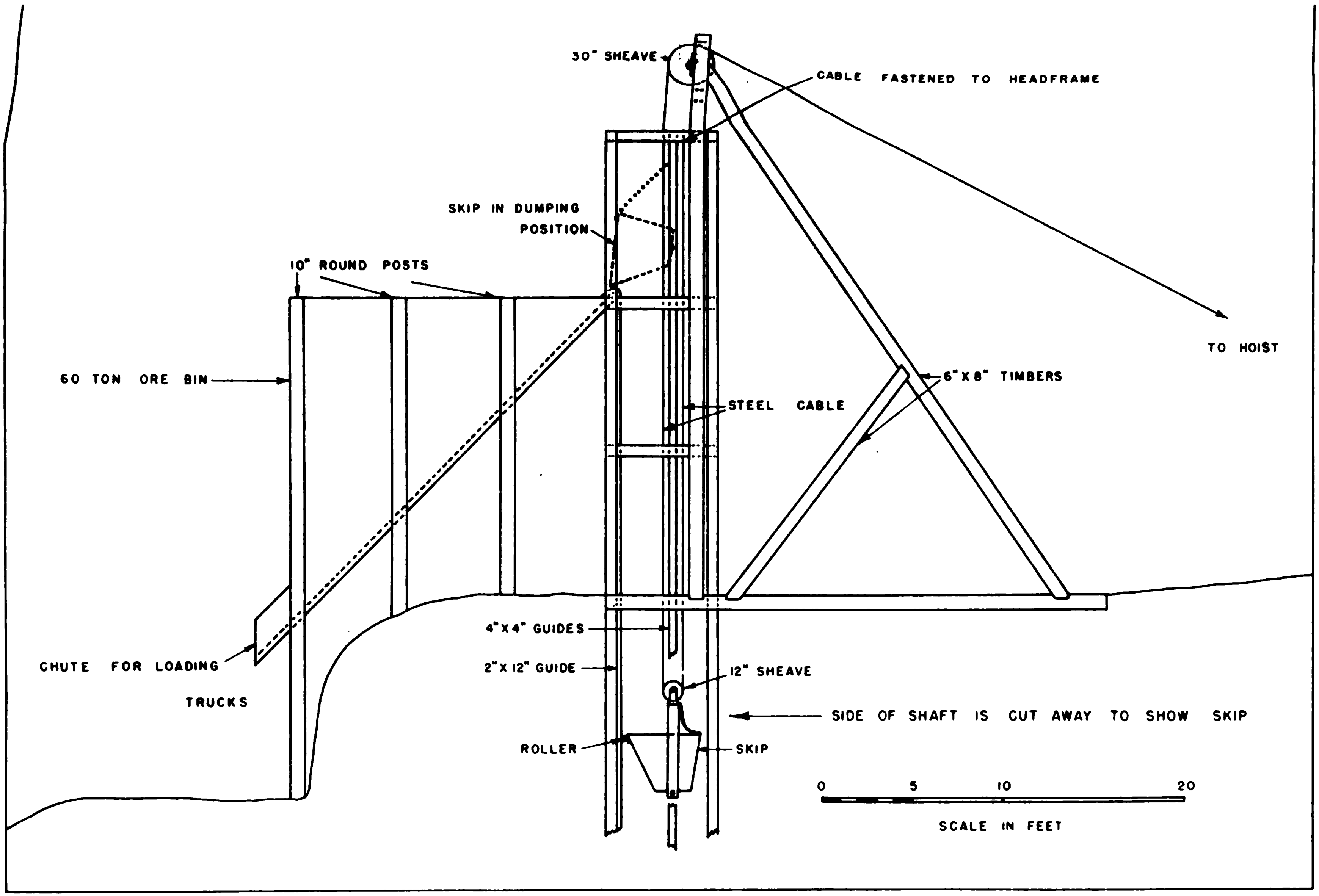

Figure 7. - Headframe, bin, and skip.

Original from THE OHIO STATE UNIVERSITY

stulls to hold the ladders in the manway. The upper part of the shaft was in diorite, but it soon went into limestone, following a narrow vein, which contained good zinc-lead ore (this ore later was hand-sorted from the waste and shipped to the mill).

After the main ore body was reached at 78 feet, the tripod headframe was discarded, and a larger, wood, A-type headframe and small ore bin were constructed at the shaft collar. However, the lessees continued to use the small, free-swinging, sinking bucket for hoisting waste and ore. The shaft was continued to about the 102-foot point before a level was started at 100 feet.

A crosscut was started northward from the shaft on the 100-foot level across the ore body, and actual stoping started from this crosscut some 20 feet from the shaft. At first, the small sinking bucket was used for hoisting ore, but it soon became apparent that no large daily tonnage could be hoisted with this equipment. The lessees then decided to buy and install a small skip in the shaft. One was finally found and purchased. It was not a regular mine skip, but was the type commonly used by building contractors for hoisting concrete in large buildings.

The installation of this new skip (fig. 7) made alterations in the shaft necessary, as the original shaft was too narrow and the walls too irregular to allow passage of the skip. The shaft first was deepened to 106 feet, so a car on the 100-foot level could dump directly into the skip when it's top was level with the track. Next, the shaft was enlarged from bottom to top by slabbing off one wall, stulls were placed at regular intervals, and skip guides were installed. As the skip was made for a building contractor, it was not designed for mine work, but had a roller at one side that was supposed to follow a special guide to keep the skip upright while being hoisted. This made it necessary to install a third guide, this one on one side of the shaft. The two original skip guides were made of 4- by 4-inch timbers, but the third guide up the side of the skip compartment was made by nailing a single line of 2- by 12-inch planks on stulls from the bottom of the shaft to the ore bin. At the ore bin, this third guide was curved over the bin so that the skip dumped automatically when hoisted above the bin top.

After the shaft had been enlarged and the guides and skip installed, it was discovered that the gasoline engine-powered hoist was too small to hoist the loaded skip. As no other hoist was immediately available, and as the operators did not want to take the additional time to install a counterweight in the shaft, a small sheave was placed on the skip bail. The end of the hoisting cable was securely fastened to the shaft headframe, the cable passed down through the sheave on the skip, then up over the main sheave on the headframe, and down to the hoist drum. Thus, by slowing the hoisting speed it was possible to raise a skipload of ore.

Drifts and Crosscuts

Up to February 1948, the only development done by drifting or crosscutting had been a crosscut that was driven a short distance northward from the shaft on the main working level. This crosscut was enlarged, and an open stope was started from it. Plans are being made to outline the ore body fully by drifting along the deposit and driving crosscuts to delimit the ore, with a new and larger working shaft farther to the west.

The original short crosscut on the 100-foot level was driven by using a 3-1/2-inch drifter with 1-inch hollow, round steel and detachable bits. An ordinary bottom draw- or toe-cut type of round was used. Forty percent gelatin dynamite with caps and fuse was used for blasting. Mucking was done by hand into 1-ton end-dumping mine cars on an 18-inch track. Cars were hand-trammed to the shaft and dumped into the sinking bucket, then hoisted to the surface. Canvas ventilation tubing was extended from the shaft to the face of the crosscut so that fresh air was blown into the face for the workers and also to clear away the smoke made by blasting.

MINING (STOPING) METHODS

The flat-lying Magdalena limestone at the Atlas No. 2 is very favorable for open-stoping methods, as the back will stand unsupported across a considerable span. Some stopes in the old Cleveland mine of Empire Zinc Co., a short distance south of the Atlas No. 2 (see fig. 2), which have an uninterrupted horizontal span of over 50 feet, have stood for almost 30 years with little or no caving. However, an occasional pillar was left in the larger stopes for back support.

At the Atlas No. 2, when the shaft had passed through the ore body, a crosscut was driven to the north from the shaft at the 100-foot point, as has already been mentioned. After this crosscut had progressed away from the shaft only a short distance, open stoping was started. Slabbing rounds were taken from the sides and back of the crosscut until a stope had been opened that was about 25 feet high from floor to back (see figs. 4 and 5). The stope floor was kept as level as possible so that track could be laid from the shaft to the working faces. Mucking originally was done by hand, the muckers shoveling into 1-ton end-dumping mine cars, which were hand-trammed to the shaft and dumped directly into the skip.

As the height of the stope increased when it was enlarged, a heading-and-bench method of mining became necessary, the heading being driven immediately beneath the overlying limestone ahead of the bench face. Occasional pillars were left for back support. A 3-1/2-inch drifter using 1-inch hollow round steel and detachable bits was used to drill the heading rounds. The heading was kept just far enough ahead of the bench face so that most of the muck from the upper face fell to the stope floor after blasting. After the heading round had been blasted and the muck was cleaned out, the ore on the bench was drilled with hand-held jackhammers to the level of the stope floor, then blasted. However, a heading always was left near the stope back so that the face could be advanced there by using an ordinary 6- or 7-foot bar for the drifter set up between bench and stope back.

Jackhammers used in removing the bench also used 1-inch, hollow, round steel with detachable bits. Forty-percent gelatin dynamite with caps and fuse was used for blasting.

In January 1948, the lessees purchased a compressed air-operated shovel loader for 18-inch track. This mechanical loader displaced all hand mucking in the mine except where it was necessary to clean up muck along the bench toe. The lessees planned to purchase a small double-drum air hoist and scraper for cleaning muck down from the bench top.

At least 9 feet of good ore is reported to remain in places in the stope floor. This ore will be broken at a later date and mucked out with the scraper.

A small electric-light plant has been bought, and lights are being installed underground. Flood lights should help increase production to a marked extent.

TRANSPORTATION

As mentioned under the section on Mining Methods, all underground ore and waste are hand-trammed in 1-ton mine cars on 18-inch track to the shaft and dumped directly into the skip. The skip then is hoisted by a small gasoline engine-powered hoist and dumped automatically into an ore bin at the shaft collar.

From the ore bin the ore is hauled by truck by a contractor for about 9 miles to a ramp at the Atchison, Topeka & Santa Fe Railroad in Silver City, where it is dumped into gondola cars. From Silver City, the ore goes via the Santa Fe to the Peru Mining Co. mill near Deming, some 45 miles to the southeast. A zinc and a lead concentrate are made at the Peru mill, these concentrates being shipped by rail to a smelter at Dumas, Tex. In November and December 1947, a few hundred tons of ore also were shipped to the American Smelting & Refining Co's. mill at Hanover, N. Mex. This ore was shipped by truck.

VENTILATION

Shortly after the mine was opened in the summer of 1947, the underground ventilation became so bad that much time was lost while waiting for smoke to clear from the mine after blasting. A small gasoline engine-powered fan on the surface blew fresh air through canvas tubing down the shaft and into the stope, but fan and tubing were too small for efficient operation.

Finally, the lessees had a 10-inch churn-drill hole drilled from the surface into the stope. An exhaust fan then was placed on the surface at the top of this hole, and for a time plenty of good air entered the mine through the shaft, the smoke and fumes being exhausted through the churn-drill hole. However, as the stope became larger, ventilation again became bad. The churn-drill hole was not large enough to exhaust all smoke completely. A raise then was planned from stope to surface for ventilation and also as a second escapeway for the workers.

DRAINAGE

Very little water has been found in the mine. The small seepage that has been found runs to a sump at the bottom of the shaft, is bailed into the skip, and then hoisted to the surface. The mine is on a hillside with a canyon some 700 feet to the southwest of the shaft, which is lower than the lowest mine working (see fig. 2). Evidently, most surface water that seeps down as far as the ore deposit drains into this canyon, probably along fault zones, as many faults occur on the property. The ground-water level should occur about 150 feet below the surface at the mine.

ORGANIZATION AND WAGE SCALE

The Atlas No. 2 mine is operated by the lessees, James Mathis and his sons, Robert and James, Jr. Two shifts are worked - day and afternoon. A foreman, who works straight day shift, is employed to supervise all operations. One miner and helper, four muckers, and a hoistman are employed on each shift. The foreman supervises the care of all equipment as well as the actual mining

The scale of wages paid at the mine in February 1948 was as follows:

	Per hour
Hoistman................	$1.25
Miner...................	1.25
Miner's helper..........	1.125
Mucker..................	1.00

COSTS

The mine owner received a premium from the Government on zinc and lead until June 30, 1947. After these premiums expired, regular market prices were received, less the regular mill deductions.

Since the mine began operating in May 1947, most of the ore has been shipped to the concentrator of the Peru Mining Co. This mill is situated at Wemple (or Peruhill) Station on the Silver City-Deming branch of the Atchison, Topeka, & Santa Fe Railroad, a few miles northwest of Deming and some 45 miles southeast of Silver City. The milling charge ranged from $4 a ton during the early months of operation to $3.50 a ton later. The freight rate on ore from Silver City to the mill was $0.34 a ton plus a 3 percent Federal tax up until about the middle of October 1947, when the rate was increased by 10 percent to $0.374 a ton, plus the 3 percent tax. Ore was trucked from the mine ore bin and dumped into railroad cars at Silver City for $1.10 a ton.

TABLE 3. - Summary of costs, in units of labor, power, and supplies

Name: Atlas No. 2 mine. Period: December 1947

Tons of ore mined and shipped: 1,553.849

Mining method: Open stope with pillars.

	Mining (stoping)
Labor (man-hours a ton):	
Mining	0.782
Mucking	0.685
Hoisting	0.232
Supervision	0.124
Total labor	1.823
Average tons per man per shift	4.389
Labor, percent of total cost	61
Power and supplies:	
Explosives (pounds per ton)	1.287
Total power (gasoline and oil):	
Air compression, hoisting, and ventilation	$172.93
Supplies and power, percent of total cost	39

Direct labor costs for the months of October, November, and December 1947 averaged $2.15 a ton. Table 4 shows costs of ore placed in railroad cars at Silver City.

TABLE 4. - Costs per ton

Name: Atlas No. 2 mine. Period: December 1947

Tons of ore mined and shipped: 1,553.849

Mining method: Open stope with pillars.

	Shifts	Total cost	Cost per ton
Labor:			
Miners	90	900.00	$0.5792
Miner's helpers	62	558.00	.3591
Muckers	133	1,064.00	.6848
Hoistmen	45	450.00	.2896
Supervision	24	1/	1/
Total labor	354	2,972.00	1.9127
Supplies:			
Gasoline and oil		172.93	0.1113
Bits and drill steel		619.00	0.3984
Explosives		2/	2/
Totals, including repairs to equipment		1,915.64	1.2328
Trucking ore from mine to railroad		1,743.94	1.1223
Total cost at railroad in Silver City		6,631.58	4.2678

1/ No direct charge made by lessee for supervision.

2/ Included in total cost of supplies.

Original from THE OHIO STATE UNIVERSITY